REMARKS

Reconsideration and allowance of this application are respectfully requested. Claims 2, 4, 18, 37-70 and 74-76 are cancelled. Claims 1, 3, 5-17, 19-36, and 71-73 remain in this application and, as amended herein, are submitted for the Examiner's reconsideration.

Applicants express appreciation to the Examiner for the telephone interview held on December 6, 2006 with Michael Murphy and Milan Pophristic, two of the inventors of the present invention, and with Applicants' attorney during which the claim rejections and arguments set out in present Amendment were discussed.

Claims 5-15, 19-28, 30, and 72-73 have been amended solely to provide proper antecedence and to have the claims better conform to the requirements of U.S. practice. None of these amendments is intended to narrow the scope of any of these claims, and no new matter has been added by these amendments.

In the Office Action, claims 1, 17 and 71 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. Claims 1, 17 and 71 have been amended to correct the informalities. It is therefore submitted that claims 1, 17 and 71 are in full compliance with the requirements of 35 U.S.C. § 112, second paragraph.

Regarding the rejections under 35 U.S.C. § 103(a): (1) claims 1-2 and 4-14 were rejected as being unpatentable over Nakamura (U.S. Patent Application Publication No. 2003/0010993) in view of Parikh (International Publication No. WO 03/026021); (2) claim 3 was rejected as being unpatentable over Nakamura and Parikh in view of D'Evelyn (U.S. Patent Application Publication No. US 2002/0155634 A1); and (3) claims 15 and 16 were rejected as being unpatentable over Nakamura and Parikh in view of Lee (U.S. Patent Application Publication No. US 2001/0034116 A1). Claims 2 and 4 are cancelled. Applicants submit that the

remaining claims are patentably distinguishable over the cited references.

For example, claim 1 as amended calls for:

> forming a doped nitride semiconductor layer by alternately growing doped nitride semiconductor material and initially undoped nitride semiconductor material repeatedly atop at least a portion of another layer *in a manner that causes part of the dopants in the doped nitride semiconductor material to diffuse into the initially undoped nitride semiconductor material* and results in *the doped nitride semiconductor layer having a doping concentration that is substantially uniform along its depth and at most 2E16 cm^{-3}*. (Emphasis added.)

The references relied on by the Examiner do not disclose or suggest alternately growing doped nitride semiconductor material and initially undoped nitride semiconductor material repeatedly *in a manner that causes part of the dopants in the doped nitride semiconductor material to diffuse into the initially undoped nitride semiconductor material*, do not disclose or suggest alternately growing doped nitride semiconductor material and initially undoped nitride semiconductor material repeatedly *in a manner that results in a doped nitride semiconductor layer having a doping concentration that is substantially uniform along its depth*, and do not disclose or suggest alternately growing doped nitride semiconductor material and initially undoped nitride semiconductor material repeatedly *in a manner that results in a doped nitride semiconductor layer having a doping concentration that is at most 2E16 cm^{-3}*.

In each of the above rejections, the Examiner relies on Nakamura as teaching "forming alternating sub-layers of doped nitride semiconductor … and undoped nitride semiconductor" and refers to layer 4 of Fig. 1 and to paragraph [0054]. However, Nakamura does not provide any teaching or motivation for forming such alternating sub-layers repeatedly *in a manner that causes part of the dopants in the doped nitride semiconductor material*

to diffuse into the initially undoped nitride semiconductor material. Rather, Nakamura describes forming the alternating sub-layers as follows:

> Subsequently, at 1050°C., *an undoped GaN layer having a thickness of 20 angstroms* is grown using TMG and ammonia gas. Next, at the same temperature, silane gas is added and *a GaN layer doped with Si* to $1\times10^{19}/cm^3$ *is grown to the thickness of 20 angstroms*. Thus, a pair of A layer made of *undoped GaN layer having a thickness of 20 angstroms* and B layer made of *Si-doped GaN having a thickness of 20 angstroms* is grown. The pair is laminated in 250 layers, resulting in a second nitride semiconductor layer 4 in the form of super lattice structure having a thickness of 1 μm. (Emphasis added.)

(See ¶ [0054].) Nakamura also describes that:

> This super lattice layer is preferably formed by laminating alternately a nitride semiconductor layer having a higher band gap energy and a nitride semiconductor layer having a band gap energy lower than that of said nitride semiconductor layer having a higher band gap energy, the two layers having different impurity concentrations. *Thickness of the nitride semiconductor layer having a higher band gap energy and the nitride semiconductor layer having a lower band gap energy* which constitute the super lattice layer *is preferably controlled to be within 100 angstroms, more preferably within 70 angstroms and most preferably within a range from 10 to 40 angstroms*. *If the thickness of the two layers exceeds 100 angstroms*, the nitride semiconductor layer having a higher band gap energy and the nitride semiconductor layer having a lower band gap energy become thicker than the elastic strain limit and *microscopic cracks or crystal defects tend to develop in the film*. ... (Emphasis added.)

(See ¶ [0038].) As pointed out by the inventors during the December 6, 2006 telephone interview, the required thicknesses for the undoped and doped GaN indicate that conduction in the superlattice is carried out using *quantum effects*. Namely, a person of ordinary skill in the relevant art would recognize from the required thicknesses that the charge carriers (electrons) in the superlattice pass from a given doped GaN sub-

layer to another doped GaN sub-layer *by tunneling* through the intervening undoped GaN. For the tunneling superlattice to operate, the dopants in the doped GaN *must be kept from diffusing into the undoped GaN* because the presence of dopants in the undoped GaN would cause the electrons to scatter and thereby degrade the charge carrier mobility. Nakamura, as noted in the above excerpt, is therefore concerned about the presence of microscopic cracks or crystal defects in the superlattice which would permit such diffusion to occur and *render the superlattice unsatisfactory for its intended purpose*. (See M.P.E.P. § 2143.01 V.) Hence, the ordinary practitioner would recognize that Nakamura neither discloses nor suggests, and in fact *teaches away* from, causing part of the dopants in doped nitride semiconductor material to diffuse into initially undoped nitride semiconductor material.

Moreover, because the dopants in the doped GaN in Nakamura's superlattice must be kept from diffusing into the undoped GaN, Nakamura likewise *teaches away* from the superlattice having a doping concentration that is substantially uniform along its depth.

The Examiner also acknowledges that "Nakamura does not explicitly state that the overall modulation-doped layer structure has an overall doping concentration of at most 2E16cm^{-3}" but contends that Parikh teaches this doping concentration and then concludes that "it would have been obvious to one of ordinary skill in the relevant art… to adjust the modulation doped layer concentration as taught by Parikh in the process of Nakamura in order to form a high quality film with improved crystallinity." Parikh, however, merely specifies an n-type GaN layer that has an impurity concentration "in the range of 5×10^{14} to 5×10^{17} per cm^3". (See claim 8, and p.8 l.29 to p.9 l.1.) As also pointed out by the inventors during the telephone interview, Parikh is *not at all concerned with* how a

lower doping concentration is actually attained in a nitride semiconductor layer and thus *does not address the problem* that known methods *cannot achieve such low doping concentrations in a manner that is both repeatable and uniform across the layer*. Therefore, Parikh does not provide any teaching or incentive for modifying the method taught by another reference to obtain a method that would address this problem.

Moreover, because Nakamura *teaches away* from diffusing dopants into the undoped nitride semiconductor material, neither reference provides any suggestion of motivation for combining the teachings of the two references. (See M.P.E.P. § 2141.02 VI.)

Further, even if the two references were to be combined in the manner asserted by the Examiner, the asserted combination would not disclose or suggest a method that includes growing doped nitride semiconductor material and initially undoped nitride semiconductor material repeatedly *in a manner that causes part of the dopants in doped nitride semiconductor material to diffuse into initially undoped nitride semiconductor material*, and the asserted combination would not disclose or suggest a method that results in a doped nitride semiconductor layer *having a doping concentration that is substantially uniform along its depth*.

The Examiner further argues that "parameters such as concentration in the art of semiconductor manufacturing process are subject to routine experimentation and optimization to achieve the desired device characteristics during fabrication" and "[t]hat it would have been obvious to one of ordinary skill in the art … to adjust the modulation doped layer concentration as claimed in the process of Nakamura in order to form a high quality film with improved crystallinity." However, even if adjusting the doping concentration in the superlattice described by Nakamura were to be considered "routine experimentation and

optimization", such adjustment of the doping concentration such adjustment would merely reduce the doping concentration in the doped nitride semiconductor material and would neither cause *part of the dopants in doped nitride semiconductor material to diffuse into initially undoped nitride semiconductor material* nor result in *a doped nitride semiconductor layer having a doping concentration that is substantially uniform along its depth*.

It follows that neither Nakamura nor Parikh, whether taken alone or in combination, discloses or suggests the method defined in claim 1, and claim 1 is therefore patentably distinct and unobvious over the cited references.

Claims 3 and 5-16 depend from claim 1. Therefore, each of claims 3 and 5-16 is distinguishable over Nakamura and Parikh for at least the same reasons. Neither D'Evelyn nor Lee, which are described in the January 31, 2006 Amendment, remedies the above-described deficiencies of Nakamura and Parikh.

The Examiner also rejected under 35 U.S.C. § 103(a): (i) claims 17 and 19-35 as being unpatentable over Nakamura in view of D'Evelyn and further in view of Parikh; (ii) claims 71-73 as being unpatentable over D'Evelyn in view of Parikh in further view of Nakamura; and (iii) claim 36 as being unpatentable over Nakamura, D'Evelyn, and Parikh in view of Sheu (U.S. Patent No. 6,712,478). Applicants submit that the claims are patentably distinguishable over the cited references.

Independent claim 17 includes limitations similar to those set out in the above excerpt of claim 1. Claim 17 is therefore distinguishable over Nakamura and Parikh at least for the same reasons.

As to the D'Evelyn reference, the Examiner also incorrectly asserts that "D'Evelyn teaches (fig. 4) a method of forming a Schottky diode, the method comprising: forming a metallic contact layer (310) atop at least part of a modulation

doped layer (302,314) to form a Schottky junction therewith". Actually, D'Evelyn shows, in Fig. 4, a photodetector having *a Schottky contact formed on an insulating layer*. (See also ¶ [0052].) As pointed out by the inventors during the telephone interview, the insulating layer prevents the device from conducting in the forward direction when the Schottky contact is forward biased so that *the device could not operate as a Schottky diode*. Hence, D'Evelyn does not disclose or suggest a method of *forming a Schottky diode* and does not disclose or suggest forming a metallic contact layer *atop at least part of a doped nitride semiconductor layer to form a Schottky junction* therewith.

It follows that neither Nakamura, D'Evelyn, nor Parikh, whether taken alone or in combination, discloses or suggests the method defined in claim 17, and therefore claim 17 is therefore patentably distinct and unobvious over the cited art.

Claims 19-36 each depend from claim 17. For at least the same reasons, each of claims 19-36 is distinguishable over Nakamura, D'Evelyn, and Parikh.

As to claim 36, Sheu does not remedy the deficiencies of Nakamura, D'Evelyn, and Parikh.

Independent claim 71 includes limitations similar to those set out in the above excerpt of claim 1 and includes limitations similar to those described above regarding claim 17. Claim 71 is therefore patentably distinct and unobvious over Nakamura, D'Evelyn, and Parikh at least for the same reasons.

Claims 72-73 depend from claim 71, and at least for the same reasons, each is distinguishable over Nakamura, D'Evelyn, and Parikh.

Accordingly, Applicants respectfully request the withdrawal of the rejections under 35 U.S.C. §§ 103(a) and 112, second paragraph.

As it is believed that all of the rejections set forth in the Official Action have been fully met, favorable reconsideration and allowance are earnestly solicited. If, however, for any reason the Examiner does not believe that such action can be taken at this time, it is respectfully requested that the Examiner telephone applicant's attorney at (908) 654-5000 in order to overcome any additional objections which the Examiner might have.

If there are any additional charges in connection with this requested amendment, the Examiner is authorized to charge Deposit Account No. 12-1095 therefor.

Dated: February 15, 2007

Respectfully submitted,

By [signature]

Lawrence E. Russ
Registration No.: 35,342
LERNER, DAVID, LITTENBERG,
KRUMHOLZ & MENTLIK, LLP
600 South Avenue West
Westfield, New Jersey 07090
(908) 654-5000
Attorney for Applicant

730276_1.DOC